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ABSTRACT

A study examines two major types of vowel systems in languages, centripetal and centrifugal. English is associated with the centripetal system, in which vowel quality and quantity (rhythm) are heavily influenced by stress. In this system, vowels have a strong tendency to move toward the center of the vowel area. Spanish is associated with the centrifugal system, which has a syllable-timed rhythm. In Spanish, vowels are located near the periphery of the vowel area and resist any movement to the center. These diametrically opposed vowel systems are subject to dynamics that further differentiate them. However, analysis of these patterns in these two languages and in others suggests that the systems are not mutually exclusive but occur on a continuum from centripetal to centrifugal. It is argued that the constraints and dynamics operating in the different systems are often neglected in the teaching and learning of pronunciation. The findings have the following implications for classroom practice: (1) production of sounds should be preceded in instruction by training in sound perception and recognition; (2) dynamics of the sound system may need to be learned before phonological units are learned; and (3) pronunciation instruction should include visual and tactile elements along with aural stimuli. (Contains 25 references.) (MSE)

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A Comparative Study of English and Spanish Vowel Systems: Theoretical and Practical Implications for Teaching Pronunciation

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A Comparative Study of English and Spanish Vowel Systems: Theoretical and Practical Implications for Teaching Pronunciation

ABSTRACT

Teaching the English vowel system to adult Hispanics appears to be a far more challenging task than teaching its consonant system. The difficulty is attributed partly to the extensive qualitative and quantitative vocalic differences between the two systems and the dynamics that control them, and partly to the significant role the vocalic system plays in shaping the rhythm type of each language. Theoretically, the study identifies two major types of vowel systems labeled here as centripetal and centrifugal; these are then associated with the traditional stress-timed and syllable-timed rhythm types. Practically, the study highlights the need to reconsider the approach to teaching pronunciation taking into account the underlying systems and structures of the native and target languages and the dynamics that govern them to secure a better understanding of the problems and to design more effective techniques to tackle them.

A Comparative Study of English and Spanish Vowel Systems: Theoretical and Practical Implications for Teaching Pronunciation

INTRODUCTION

In teaching English pronunciation to ESL/Bilingual students, there are instances when teachers unjustifiably emphasize the segmental elements (vowels and consonants...) at the expense of the suprasegmental ones (stress, rhythm, intonation...). There is also a tendency to treat the two elements as isolated entities, thus obscuring the underlying relationship that may exist among them as units of the whole. Moreover, there are instances when the teacher knowingly identifies a certain element/aspect of pronunciation and grants it more weight and time simply because that given element/aspect is a serious source of difficulty, therefore ranking high among the causes of mispronunciation and semantic confusion. The latter category is intimately related to this study.

In an earlier study (Odisho, 1990), the author emphasized the view that in teaching English pronunciation to adult Hispanics, the vocalic system of English poses far more serious problems for them than the consonantal system. This was attributed to four factors:

First, the two vowel systems are drastically different, both qualitatively and quantitatively.

Second, the dynamics that control the qualitative and quantitative variation of the vowels are diametrically opposed to each other.

Third, a strong relationship seems to exist between the vowel systems of the two languages and their rhythm types.

Fourth, the presence of a general one-to-one grapheme-phoneme correspondence of vowels in Spanish as opposed to a highly inconsistent grapheme-phoneme correspondence of vowels in English raises serious problems for Hispanic students when literacy skills are involved. For instance, in Spanish the letter a tends to retain its phonemic value very consistently, whereas in English it can render a wide variety of phonemic values such as / ə /, / æ /, / a /, / ɔ /, / e / and / ɛ / in above, apple, arm, ball, able and any, respectively.

In an attempt to restrict the scope of this paper, the fourth factor will be completely excluded from this discussion since it constitutes a pronunciation problem only when literacy skills are involved. The first factor will be considered only to the extent it is relevant to the second and third factors i.e., the dynamics of the vowel system and its relationship to rhythm type. It is these two factors that will constitute the bulk of this study.

DISCUSSION OF VOWEL SYSTEMS

Vowel quality, also known in literature as timbre (MacPherson, 1975) or vowel color (Delattre, 1965) stands for the acoustic/auditory impression of the vowel on the ear. It results from the differences in tongue and lips configurations and other concomitant articulatory maneuvers required for the production of a given vowel. The basic three parameters for vowel description are: front/back, high/low, and lip-position i.e., rounded/

unrounded. Using those three parameters, English has a minimum of 11-12 basic vowels (Delattre, 1965; Prator & Robinett, 1971; Whitley, 1986) depending on the variety of English being described. They are: / i /, / ɪ /, / e /, / ɛ /, / æ /, / a /, / ɔ /, / o /, / ʊ /, / u /, / ʌ /, and / ə / as in beat, bit, bait, bet, hat, hot, bought, boat, pull, pool, but and about.

Spanish, on the other hand, has five basic vowels (Stockwell & Bowen, 1965; Delattre, 1965; MacPherson, 1975; Navarro, 1968; Dalbor, 1969; Whitley, 1986) / i /, / e /, / a /, / o / and / u / as in piso, peso, paso, pozo and puso, respectively. No discussion of the diphthongs or other combinations of vowels will be made here since their quality is essentially based on the quality of the basic vowels in the two languages.

Vowel quantity, length or duration is another feature that accounts for further differences between Spanish and English. In English, this feature has been somewhat controversial. The controversy is reflected in the manner in which linguists transcribe words that are thought to display quantitative contrast. For instance, the vowels in beat and bit have been transcribed differently as: /i:/ vs. / i / (Jones, 1909), /iy/ vs. / i / (Trager & Smith, 1957), / i:/ vs. / I / (Gimson, 1967), / iy / vs. / I / (Prator & Robinett, 1971) and / i / vs. / I / (Kenyon & Knott, 1953). As the transcription portrays, there seems to be a disagreement on whether the difference is only quantitative as in Jones, or only qualitative as in Kenyon & Knott, or a combination of both types of differences as in the rest of the cases where :

designates length and y designates diphthongization which entails length.

Recently, the feature tense/lax has been gaining ground as the basis for the distinction of the so-called long/short vowels of English such as beat/bit and pool/pull. Unfortunately, even this feature does not seem to have a well-established and acceptable definition and, apparently, it will remain so (MacKay, 1978) because an objective measurement of the degree of tenseness or laxness in the muscles of articulation has not yet been possible (Delattre, 1965). When Ladefoged (1982) tried to apply this feature to classify the English vowels, the result was a general association of tenseness with length and laxness with shortness (P. 81) an association that has been repeatedly attested in literature (Chomsky & Halle, 1968; Jakobson et al, 1969).

However, despite these differences in transcription, it has not been suggested by any linguist that the qualitative and quantitative differences between the above types of vowels in English are mutually exclusive. Consequently, to the extent it concerns English, this study will treat the two features as interdependent i.e., they entail each other. Delattre (1965) corroborates this view by stating that in English, the role of duration in the i/I type distinctions is certain, but not considerable. It is probably smaller than the difference in color (P. 63). Regardless of whether quantity plays a primary or secondary role in English, it is a part of the English vowel system. Unlike in English, quantity in Spanish does not have a

functional role (MacPherson, 1975, P 41). Navarro (1968) also affirms this observation and states that the characteristic feature of Spanish pronunciation is the brevity of its vowels, whatever the degree of stress of these sounds may be and the form of the syllable in which they appear (P. 50).

But, so far, the comparison between the English and Spanish vowel systems has been confined to the segmental elements without any consideration for any possible interaction between these segments and the suprasegmental ones. In the remaining part of this section, attention will be focused on the interaction of the vowel system with stress in each language. It is this interaction that constitutes what we call the dynamics of the vowel system.

In English, vowel quality and quantity fall heavily under the influence of stress and this interaction is part of the dynamics of the vowel system. The location of stress and its strength within the word or sentence greatly influence the vowels both qualitatively and quantitatively. In syllables with a primary stress, vowel quantity (length) reaches its maximum and quality is very distinct. In syllables with a secondary stress or a weak stress, both quality and quantity of vowels are reduced drastically. In unstressed syllables, almost all English vowels can be reduced to either [ə] or [I] vowel quality (Dalbor, 1969;p 153) which also implies a major reduction in quantity since both vowels are the shortest of all in English. Ladefoged (1982) confirms this fact in stating that the symbol [ə] may be used to designate all vowels that have a reduced vowel quality (P. 86). Dale and Poms' (1985)

statement, that [ə] is the sound that results when any vowel in English is unstressed in a word, further supports this salient trend in English (P. 94).

Such a qualitative and quantitative vowel reduction, hereafter labeled schwaization after the neutral vowel [ə] schwa, is a typically characteristic feature of English, but very uncharacteristic of Spanish. In their teaching instructions for the Spanish learners of English, Dale and Poms (1985) sum up their instructions as follows: In Spanish, all vowels are pronounced clearly and distinctly, even in unaccented syllables of words. The schwa [ə] does not exist. In English, unstressed vowels should receive much less force than unstressed vowels do in Spanish. In order to sound like a native English speaker, you must obscure any vowels that are not in accented syllables of words. Vowel reduction to [ə] is not sloppy speech. It is an important feature of spoken English (P. 94).

Navarro (1968) highlights the same characteristic feature of Spanish in a broader context: Spanish does not use relaxed and colorless vowels analogous to the mute e of French or the unaccented e of Portuguese and Catalan (P. 29). Obviously, the contrast between English and Spanish in this respect should be even greater since neither of those languages with which Spanish is compared matches English in its susceptibility to schwaization. Nevertheless, the situation in Spanish should not be misconstrued as the absolute absence of qualitative and quantitative vowel susceptibility to change. Navarro does not let this fact pass

unnoticed; in fact, he emphasizes this in different contexts. For vowel timbre (quality), he states that each vowel, under certain circumstances, undergoes perceptible changes, but without altering the phonological unity or the semantic value of the words (P. 28). With regards to quantity, he points out that in the stressed vowels one is ordinarily aware of a certain greater length as compared to those in weak syllables (P 50), but no vowel is shortened as to become muffled or silenced (P. 51). Vowels in Spanish may also occasionally be given some length for stylistic reasons and emphasis (MacPherson, 1975).

The above comparison of English and Spanish demonstrates two diametrically opposed vowel systems that are subject to different dynamics further enhancing the differences. English has a range of vowel quality that is, at a minimum, twice as broad as that of Spanish. Vowel quantity, regardless of whether it is the outcome of long/short or tense/lax feature, is certainly more relevant in English than in Spanish. English has vowels with at least three phonetic lengths typically represented by / i /, / I / and / ə /. It is because of this Stockwell & Bowen (1965) describe English as having three vowel systems in different environments within words, whereas Spanish has only one system that does not vary significantly from one position in a word to another (P. 86).

Perhaps, most important of all for English is the fact that schwaization can pull almost all vowels to the center (Whitley, 1986) thus reducing their tenseness and length to the minimum. Delattre (1965) confirms this statistically by revealing that 90%

of the unstressed vowels turn to some sort of schwa (P. 55). Thus, English has a system that tolerates a wide variety of vowels ranging from very tense to very lax and from very long to very short. Such a vowel system is best labeled as centripetal, wherein the vowels have a strong tendency to move to the center of the vowel area where schwa is located. Figure 1 below shows a

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Insert Figure 1 about here

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schematic plotting of the vowels of English based on the works of Delattre (1965 & 1969) and MacKay (1978). They fall into three general categories: / ə / schwa is in the center, some are near the periphery, while others are in between. The length of the arrows indicates the extent of reduction in vowel quality (schwaization) and reduction in vowel quantity (longer to shorter and/or tenser to laxer). By contrast, the schematic diagram in Figure 2, based on the works of Delattre (1965; 1969), shows the

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Insert Figure 2 about here

Spanish vowel system which is best labeled as centrifugal, in which the vowels are located near the periphery of the vowel area and resist any movement to the center. It is a system of tense vowels with no tolerance for lax vowels. This is why in Spanish all vowels in all syllables are pronounced almost equally; syllables are rarely lost or reduced as they are in English (Dale & Poms,

1985; P 137).

Before any relationship between the centripetal/centrifugal contrasts of vowel systems and the stress-timed and syllable-timed rhythm contrasts is investigated, some knowledge about the nature of rhythm is indispensable to make the whole picture more comprehensible.

DISCUSSION OF RHYTHM TYPES

Rhythm is usually defined as the alternation of stressed and unstressed syllables in a sentence (Benware; 1986). Different languages have different types of rhythm. Generally speaking, a dichotomy of stress-timed rhythm and syllable-timed rhythm is recognized by many linguists (Adams 1979; Dauer, 1983). However, there are some linguists who tend to think that the concept of a dichotomy is too rigid a characterization to realistically portray the nature of rhythm in human language. Ladefoged (1982) states that perhaps a better typology of rhythmic differences among languages would be to divide languages into those that have variable word-stress (such as English and German), those that have fixed word-stress (such as Czech, Polish and Swedish) and those that have fixed phrase-stress (such as French) (P. 224). But since there is more than one factor that determines the nature of rhythm in a given language there is no compulsion to have one or the other of the stress-timed or the syllable-timed rhythmical bases (O'Connor, 1973; P. 239). The validity of a dichotomy or Ladefoged's trichotomy will be assessed later; meanwhile, we need to understand what is meant by a stress-timed or syllable-timed

rhythm.

A stress-timed rhythm is the one in which stressed syllables tend to recur at regular intervals of time and the syllables vary considerably in length depending on whether they are stressed or unstressed. On the other hand, a syllable-timed rhythm is one in which each syllable tends to retain, more or less, the same duration regardless of stress (Adams, 1979; Ladefoged, 1982; Roach, 1983). In the stress-timed rhythm, only syllables receiving the primary stress stand out prominently, while the unstressed syllables are reduced and compressed in time to become far less prominent. Unlike such uneven distribution of prominence, in the syllable-timed rhythm, all syllables, stressed or unstressed, receive a relatively even prominence; syllables take approximately the same time, and the overall length of an utterance depends on the number of syllables involved. In other words, in this latter type of rhythm there is hardly any noticeable reduction in the prominence of the unstressed syllables.

It is in light of the above-mentioned characteristics that English is said to have a typically stress-timed rhythm, whereas Spanish is said to have a typically syllable-timed rhythm. To demonstrate how rhythm operates in both English and Spanish, MacPherson (1975) cites the following sentence for Spanish,

Juan no sabe lo que dijo Pepe

which has ten syllables, but five stressed ones,

Juán nó sá be lo que dí jo Pé pe.

MacPherson elaborates on the above sentence in the following man-

ner: The five stressed syllables, although pronounced with greater muscular force and therefore more prominent, are neither longer nor shorter in duration than the five unstressed syllables. Each of the ten syllables is equally clear-cut and takes up approximately the same length of time (P. 34).

In contrast to the Spanish example, MacPherson compares the following two utterances,

a-	nine	big	black	cats
b-	ninety	enormous	vermillion	curtains

to illustrate the difference in syllable behavior between Spanish and English. He concludes that the lapses in time between the stressed syllables in b are either equal to or only very marginally greater than those between the stressed syllables of a despite the fact that the phrase in b is six syllables longer. The extra syllables are crushed up more closely together, and the time devoted to the stressed syllables correspondingly shortened (P. 35).

Now that the two vowel systems, their dynamics and their rhythm types have been expounded, one needs to find out whether there is a connection between the centripetal vowel system and the stress-timed rhythm type, on the one hand, and a centrifugal vowel system and a syllable-timed rhythm type, on the other hand. To answer this question one has to recall the salient characteristics of the vowel system in each language. If in Spanish the vowels tend to retain their relative quality and quantity, regardless of stress, and if they never undergo any schwaization or even vowel

reduction, how does one expect the syllables to be manifestly different in length and prominence? A univalent system of vowels should undoubtedly yield a temporally uniform and univalent type of syllables, which is typical of a syllable-timed rhythm as in Spanish. By contrast, a multivalent system of vowels combined with a very pervasive tendency toward schwaization, one should definitely expect multivalent types of syllables, a highly typical situation with a stress-timed rhythm as in English.

The situation with Classical Arabic (Figure 3) is somewhat

Insert Figure 3 about here

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different. Classical Arabic, like Spanish, does not allow vowel reduction or schwaization, but it does utilize the feature quantity (length) to double its / i , a, u / vowels, a trend that it shares with English. This type of evidence from Arabic indicates that its vowel system has features that belong to both the centripetal and centrifugal vowel systems. Consequently, it does not strictly belong to either one of them. On a vowel system continuum, classical Arabic occupies a middle position between English and Spanish. By the same token, this variety of Arabic should not be exclusively identified with the stress-timed or syllable-timed rhythm type. Here again, it should occupy a midway position on the rhythm continuum. This, certainly, is a call for reconsideration of the predominant view (Abercrombie, 1967) that Arabic, per se, is a stress-timed language. Such a view is more applicable to

Colloquial Arabic, whose vowel system is drastically different from that of Classical Arabic.

This is a synchronically motivated judgment. If phonologically the vowel system of a given language does not maintain long/short or tense/lax contrasts, if it does not have a schwa as part of its phonological system, and if it does not tolerate schwaization or a tangible degree of vowel reduction, it implies the presence of a synchronic constraint on the extent to which stress can alter the quality and/or quantity of its vowels. It is true that stress in Spanish can change vowel quality and quantity, but the change will still be confined to the phonetic domain. Thus, in Spanish, vowels may phonetically be somewhat longer/shorter or tenser/laxer, but the absence of phonological contrasts based on those features will deny the language the potential for creating syllables that are significantly different in length and prominence.

This argument in favor of binding the rhythm type to the vowel system does not mean that the vowel system is the only factor that determines the rhythm type in language in general, or in any one given language. Undoubtedly, other factors such as syllable structure (Dauer, 1983), fixed/variable word stress and word/phrase stress (Ladefoged, 1982) are at play. However, this study sought to highlight the significant role of the vowel system and its dynamics.

THEORETICAL AND PRACTICAL IMPLICATIONS

The discussions above seem to lead to some theoretical and

practical implications for the teaching of pronunciation, in general, and the teaching of vowels, in particular. Theoretically, there is clear evidence that vowels in both English and Spanish are interrelated as parts of a whole system in which vowel quality and quantity are subject to certain constraints, and changes are governed by specific internal dynamics. Those constraints and dynamics represent some of the most neglected areas in the teaching and learning of pronunciation. This study focuses the attention on those areas through the identification and recognition of the dichotomy of centrifugal and centripetal vowel systems.

The discussions further reveal a strong relationship between the vowel systems and rhythm types. A language with a typical centrifugal vowel system, such as in Spanish, goes with the so-called syllable-timed rhythm type, whereas a typical centripetal vowel system, such as in English, goes with a stress-timed rhythm type. Although such a link is perfectly valid for English and Spanish, the broader validity of the link requires further investigation of more languages. However, inasmuch as English and Spanish are concerned, the approach to teaching their pronunciation should observe the significance of the link and should plan the teaching strategies accordingly.

Inasmuch as the approach is concerned, it is not enough to simply compare and contrast the vowel systems and the units they encompass. It is absolutely essential to grant consideration to the internal dynamics that govern the units especially in regards to vowel quality and quantity changes in different linguistic

contexts. Those dynamics do not only determine the nature of the vowel system (as centrifugal-oriented or centripetal-oriented), but they also impact the nature of the overall rhythm type (as syllable-timed or stress-timed.)

In case of the Spanish and English vowel systems, the difference is not confined to the fact that the former is a 5-vowel system whereas the latter is a 12-vowel system. It is the dynamics of the vowel reduction, in general, and schwaization, in particular, in English and their absence in Spanish that enhance the difference. In short, no attempt to study or teach those two systems would be comprehensive, efficient and instructionally rewarding without an integrated consideration of the vowel systems, their dynamics and the rhythm types.

As for the teaching strategies that emanate from the above approach, there are three that are foremost in importance. Firstly, teaching pronunciation does not begin with teaching the production of sounds. This phase, especially in the case of adults, should be preceded by intense ear-training in the perception and recognition of sounds as whole units or as features that jointly occur to generate the whole units. According to this strategy, teachers have to develop exercises and drills that help learners realize how front vs. back, high vs. low, short (lax) vs. long (tense), and rounded vs. unrounded vowels are distinguished from each other. The perception and recognition phases prepare the brain to recognize, accept and internalize the new sounds or sound features. Once the sounds and the features are internalized, the

brain will be in a better position to program the appropriate articulatory commands and fire them to the vocal organs to generate the targeted sounds or features. Most of the failure that we as teachers experience in teaching pronunciation seems to be the direct result of bypassing the perception and recognition phases and immediately plunging into the production phase; this is a shortcut that often leads to mispronunciation.

Secondly, as an extension of the first strategy, the dynamics of the vowel system may require further exercises and drills that enable the learners to master the basics of those dynamics before even concentrating on the units of the system. This will provide the learners with the skill of articulatory maneuvering to allow the tongue and the lips to assume a wide variety of vowel postures. For instance, the Hispanic learners of English should be first trained in the perception, recognition and production of vowel reduction and schwaization prior to dealing with individual vowels or even pairs of vowels. For the English learners of Spanish, the training in perception and recognition should focus on how to avoid schwaization and vowel reduction since Spanish is a typically non-schwa language whereas English is a typically schwa language.

Thirdly, the predominant misconception in the field of teaching pronunciation is the belief that pronunciation is strictly taught through a model-produce technique i.e., the teacher models the problematic sound and the learner repeats after him/her. This often implies that pronunciation is the exclusive function of the auditory channel, whereas, in actual fact, teaching pronunciation

is greatly facilitated and reinforced through visual observation and tactile sensing (Odisho, 1991). One can even solidly state that all sounds, both vowels and consonants, in which the lips (and occasionally the tip of the tongue) are involved may be described as visible sounds. For instance, the production of / i / vs. / u/ displays maximum visual distinction. The English interdental fricatives / ð / and / θ / are some of the most frequently mispronounced sounds by L2 learner of English not because there is an inherent difficulty in their articulation, but rather because teachers tend to teach them auditorily with minimum, if any, emphasis on their visual formation and tactile sensing. Classroom experience shows that when their visual and tactile formation features are utilized the sounds / ð / and / θ / becomes the easiest ones to teach.

In short, teaching pronunciation is not a mechanical process in which isolated sounds keep moving to and fro between the mouth and the ear. To put it differently, it is not a process that is singularly based on the auditory channel. Teaching pronunciation is a far more sophisticated process in which the auditory input is reinforced by input from other senses. Without a multisensory approach coupled with some cognitive orientation, it is extremely difficult to teach pronunciation to adult learners of L2 who usually display considerable psycholinguistic resistance in their acquisition of new sounds due to native language constraints and long regimentation within those constraints.

CONCLUSIONS

A successful approach to teaching English pronunciation in ESL and Bilingual classes should be a comprehensive and integrated one. A comprehensive approach requires that all components of pronunciation, both segmental and suprasegmental, be covered. The integrated nature of the approach means that those components should not be handled in isolation because, firstly, they are complementary in nature, and secondly they often tend to be systematically interrelated, bearing a relationship not easily captured without appropriate knowledge and experience in the targeted L1 and L2. The vowel system and rhythm type relationship in English and Spanish is a case in point.

Information accumulated in this study of English and Spanish points in the direction of a vowel-rhythm dependence. Further information based on an initial investigation of German, French, Italian, Arabic and Neo-Aramaic vowel systems tends to support this suggested dependence.

Due to the differences in the range of vowel quality/quantity and the dynamics that control it, languages tend to cluster themselves around two major types of vowel systems identified here as the centripetal and centrifugal. However, evidence also suggests that these two types of vowel systems are not mutually exclusive in the sense of a dichotomy. Instead, vowel systems seem to array themselves along a continuum, some of them leaning heavily towards a centripetal system, others leaning heavily towards a centrifugal one, and still others occupying a position in between.

For instance, English has a centripetal vowel system and Spanish a centrifugal one, but Arabic generally has a system that falls between English and Spanish.

By the same token, the concept of a continuum seems to promise more accurate descriptions and identifications of rhythm types as opposed to the traditional dichotomy of stress-timed and syllable-timed rhythms. On such a continuum, English will solidly occupy a position near the stress-timed end, Spanish will occupy a position near the syllable-timed end, with Arabic falling somewhere in between. In fact, on such a continuum one may even accommodate for different varieties within the same language; Jamaican English as opposed to British or American English may be a case in point (Dauer, 1983). No doubt, more definitive conclusions in this area require more in depth and extensive investigation.

From a pedagogical point-of-view, a better understanding of the underlying structures and systems of a language will greatly help in the improvement of its instructional techniques. The comparative study of English and Spanish has revealed certain interesting aspects of those two languages which will hopefully encourage teachers to reconsider their understanding of the two languages and their instructional methodology.

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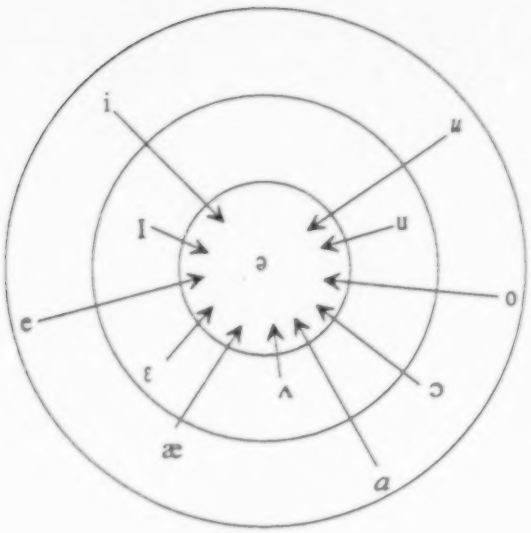

Fig. 1, The English vowel system, a typical centripetal system in which vowels of different quality and/or quantity move between the periphery and the center of the vowel area. The arrows show drastic internal movement.

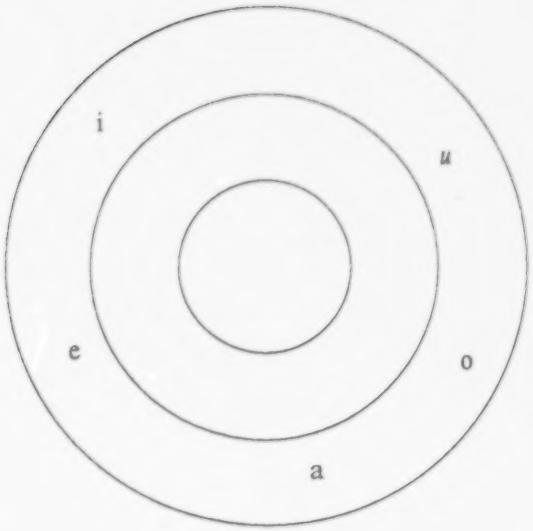

Fig. 2, The Spanish vowel system, a typical centrifugal system in which vowels tend to retain their stable quality and/or quantity with minimum change.

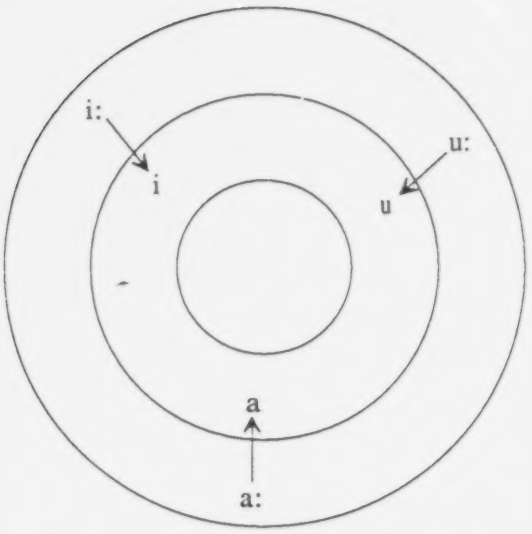

Fig. 3, The Arabic vowel system in which variation in vowel quantity is consistent with a centripetal vowel system, whereas the restricted variation in vowel quality and the absence of schwaization is consistent with a centrifugal system.